Ontario Resources

FOREST RESEARCH NOTE

1987 No. 44

Growth and Quality of Red Oak Planted in a Jack Pine Plantation

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Introduction

In the northern mixedwood and hardwood cover types of Ontario, red oak (Quercus rubra L.) is one of the major species. However, the relatively large supplies of high quality timber have disappeared through overcutting during the last century, and Ontario is now importing veneer logs of red oak from the USA, along with other heavy hardwoods (Blyth and Smith 1984, Nevel et al. 1982). Good growth, high quality and high market value make red oak a very desirable species for a great variety of products. Some industries depend on good quality oak and demand for sawlogs and veneer in southern Ontario is expected to double by the year 2025 (OMNR 1982). This would justify promotion of the regeneration and growing of red oak in southern Ontario and to study its performance following planting under a variety of conditions in both hardwood and conifer stands.

There are a few successful red oak plantations in southern Ontario forests but only one is known to have been documented (Stroempl and Beckwith 1978). This note illustrates one of several examples underway in Forest Districts of Algonquin and Central Regions, Ontario, where red oak is underplanted or interplanted in stands conventionally rated as "exclusive" pine sites.

Materials and Methods

The jack pine plantation

The plantation of 11 ha is located on the Hendrie Tract in Simcoe County Forest, Huronia Forest District, Central Region, Ontario (lat. 44°25' long. 79°44').

The topography is flat with soils of the Tioga series, described as well-drained, slightly acid (pH 4.3-6.2 in humus and mineral soil at Hendrie), usually stonefree sandy loams to loamy sands, developed on deep, somewhat calcareous outwash sand (Hoffman and Wicklund 1962).

The plantation was established in 1923 at 2 by 2 m spacing, and has developed into a fully stocked stand (Fig. 1). At time of planting, there were a few red oak clumps of sprouts which have persisted. Following canopy openings due to natural mortality, wind damage or thinnings since 1947, most of the forest floor has become covered by dense bracken fern (Pteridium aquilinum (L.) Kuhn) with scattered regeneration of jack pine (Pinus banksiana Lamb.), white pine (Pinus strobus L.), red maple (Acer saccharum Marsh.) and northern red oak (Quercus rubra L.).

In 1947, 12 experimental plots, square or rectangular in shape and 0.1 ha or 0.2 ha in size, were laid out in this jack pine plantation. Nine plots have undergone eight moderate or light thinnings from below: the first six thinnings between 1947 and 1973 and the last two in 1978 and 1983. Three control plots were laid out in the least disturbed (unthinned) areas. The stand conditions before and after the underplanting of oak in 1976 are described in Table 1.

The red oak planting stock

The 2+0 stock with an average height of 50 cm was grown at the St. Williams nursery of the Ministry of Natural Resources, Ontario. The roots of the stock were

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Ontario Tree Improvement and Forest Biomass Institute
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88-04325/

Figure 1. Red oak 3.7 m in height 11 years following planting in the jack pine plantation. Note older natural red oak at right background.

severely pruned to about 20 cm from the root collar at the planting site as recommended (Johnson 1984, Olson 1972, Russell 1973, Stroempl 1985), to facilitate the planting of 2,225 seedlings by the half-hole method (USDA 1984) using standard fire shovels. Trees were planted "deep", i.e., at a depth of about 7 cm above the root collar, 1.5 m apart in rows 3 m apart on May 3-5, 1976, with rain or wet snow falling during the first 36 hours.

Statistical analysis

Standard t-test or chi-square procedures at the 1% and 5% levels of significance were used to calculate differences in basal area, height, diameter and quality.

Results

After 11 growing seasons the planted oaks were assessed for survival, total height and stem quality. The criteria used for assessing quality are given in Table 2.

The average survival ranged from 84% to 87% without statistically significant differences between treatments (Table 3). There were more good undamaged trees in the moderately thinned plots (76%) than in the control (64%); differences were significant at 1% level. However, in the light thinning the percent of good undamaged trees was not significantly higher than in the control. There were no significant differences in the percent of fair and poor tree quality classes between any of the treatments.

The average heights of good undamaged trees in both thinnings were the same at 2.9 m and not significantly greater than in the controls at 3.1 m. Comparing good undamaged with good damaged trees, there were only significant differences in the control (at 1% level) but not in the thinnings.

The tallest good undamaged trees in the control and thinned plots were 5.1 m and 5.25 m, respectively.

TABLE 1 Jack pine plantation conditions before and after red oak planting in 1976.

Stand treatment	Plots per treatment		Stand conditions in 1973				Stand conditions in 1986				Basal area	
			Trees per hectare	Dominant height	Diameter b.h.	Basal area	Trees per hectare	Dominant height	Diameter b.h.	Basal area+	S.D.	No. Observations++
	n	ha	n	m	cm	m^2	n	m	cm	m^2		
Moderate thinning	5	0.5	525	20.1	21	22	400	21.9	24	16.5b	3.79	70
Light thinning	4	0.4	750	20.4	20	26	600	22.5	22	b21.5a**	4.93	50
Control	3	0.3	1200	20.4	18	30	900	22.5	20	a*23.5a**	5.69	60

Means followed by different letters are statistically significant at 1% level** or 5% level* of probability between treatments.

+ Basal area range: Moderate thinning 9.2 - 24.1, light thinning 12.6 - 29.8, control 13.8 - 39.0

++ Normal distribution (0.01)

TABLE 2 Quality criteria for assessing tree class, crown position and damage to the planted oak.

Quality Class	Red oak quality criteria	
	Undamaged[+]	Damaged[++]
Good	Crown dominant or codominant	Top broken with one lateral assuming apical dominance. High double fork at top or upper one-half of stem height. Previous stem defect still identifiable.
Fair	Crown intermediate, partially suppressed *(by neighbouring planted or natural oaks, or red maple)	Flat crown. Top broken with apical dominance yet undetermined. Multiple high forks. Low fork with one stem vigorous. Previous stem defect prominent.
Poor	Crown suppressed * (as above)	Top broken, no recovery. Low fork, poor vigour. Severe defect at stem base and poor to no resprouting.

[+] Includes few trees with insignificant damage of excellent recovery.
[++] Includes damage persisting for several years or recent damage.

TABLE 3 Survival, stem quality and height growth of red oak planted in the jack pine plantation (average data 1976-86).

Stand treatment	No. oak		Survival	Stem quality(%) and height(m)									
				Good				Fair				Poor+Dead	
	total	per ha	1986	Undamaged		Damaged		Undamaged		Damaged		All	
	n		%	%	m	%	m	%	m	%	m	%	m
Moderate thinning	767	1515	87	76++a	2.9**a	2	2.2	1	1.9	8	1.6b	13	0.9
Light thinning	633	1565	85	72	2.9**a	4	2.3*a	2	1.9	7	1.6b	15	0.9
Control	825	1630	84	64b	3.1**a	6	2.1**ab	5	1.7b	9	1.7b	16	0.9
All	2225	1570	86	71	2.9**a	4	2.2**ab	3	1.8b	8	1.6b	14	0.9

Means with different letters are statistically significant at 1% level** or 5% level* of probability within treatments and at 1% level++ between treatments.

Discussion and Recommendations

The red oak plantation to this stage is a success. There were at least two "very damp" summers during the 11 years, the last one in 1986, encouraging luxuriant mildew which may have slowed the growth of oaks. Other negative influences during the earliest years were slight to mediocre, occasionally severe, rodent girdling or clipping and deer browsing, inconsistent from year to year. Frequent traffic around and easy access through this plantation generally presented a poor shelter for animals. Occasional windthrown trees or broken crowns of jack pine also damaged oak tops and stems. Although the resprouting capacity of oak following mechanical damage is known to remain high under most stand conditions, the growth of sprouts is poor and they will eventually perish under prolonged severe shade by a "carpet" of bracken fern.

The survival and early development of oak varied little with the degree of canopy opening at the time of or a few years following planting. Natural oaks of good quality, scattered throughout the surrounding thinned plantations under a variety of canopies, underline the wide tolerance of oak to shade. Shoots of underplanted oak seedlings during their early years were observed to grow little before release, but the seedlings developed good root systems (Johnson 1984, Oliver 1978).

Jack pine as a pioneer species fulfilled its purpose of covering a denuded area to prevent soil erosion and creating ecologically favourable conditions for a stand conversion towards red oak, often in combination with white pine, both historically known as having a high log quality and value.

In similar situations where a jack, red or Scots pine site lends itself to a conversion, with red oak as a major component, oak could be introduced immediately after the last thinning or several years before the complete stand removal; this would assure establishment under shelter without serious ground competition. Good growth of established red oak can be secured by prescribed burning which would control competition from ground vegetation and stimulate rapid stump-sprouting to escape extreme browsing. This suggestion is based on the excellent resprouting capacity of red oak after successive burns (Keetch 1944, Rouse 1986). White pine could be interplanted with red oak after a burn.

Options for managing this stand:

1/ The jack pine will be left to collapse naturally causing breakage to some oaks, but benefiting those unharmed, planted and natural. Where oak is plentiful, the jack pine and other regeneration must be controlled, to allow establishment of more planted oak stock, preferably with white pine, until the free-to-grow stage (2 m high).

2/ The jack pine will be clear-cut, with or without log extraction, followed by a prescribed burn, to encourage vigorous resprouting of oak. Additional oak and white pine should be planted in areas void of oak regeneration. Since burn promotes seed-bearing cones to open, controlling jack pine regeneration may be necessary to release newly planted oak and white pine.

3/ The jack pine will be clear-cut and logged, and tops will be sectioned to facilitate planting of oak and white pine where stocking is unsatisfactory. Oaks, damaged during cutting or skidding of jack pine, should be decapitated at the ground line to encourage vigorous quality-stump sprouting. Advanced jack pine and other regeneration must be controlled where it is plentiful to allow maximum oak and white pine establishment.

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(.9KP.R. 87 08 26)
ISSN 0381-2650